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Haldimand-Norfolk soil survey: pedotechnical interpretations

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Haldimand-Norfolk soil survey: pedotechnical interpretations

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PREFACE

A soil survey of the Ontario Regional Municipality of Haldimand-Norfolk has recently been completed and published as Report No. 57. Soil surveys describe the pedological aspect of soils and their application to agriculture and other land uses. Engineers and planners also make use of soil survey information. The publication is complementary to the Haldimand-Norfolk soil survey report. Graphic illustrations are provided to supplement the written descriptions given in the report. It is presumed that engineering users of soil surveys require information about the landscape and its soil characteristics. The term pedotechnical defines this special use and the object of this publication is to encourage more effective use of soil surveys by these professionals.

PREFACE

Des travaux de prospection pédologique ont pris fin récemment dans la municipalité régionale de Haldiman-Norfolk, en Ontario, et ont été publiés dans le rapport n° 57. Ils décrivent les aspects pédologiques des sols et leur application en agriculture et à d'autres usages. Des ingénieurs et des planificateurs utilisent aussi à ces fins les données de la prospection pédologique. Cette publication complète le rapport sur les travaux de prospection à Haldimand-Norfolk. Ces graphiques illustrent les descriptions présentées dans le rapport. On a supposé que les spécialistes utilisant la prospection pédologique désirent avoir des informations sur le paysage et sur ses caractéristiques pédologiques. Le terme pédotechnique définit cet emploi particulier, et la présente publication a pour but de favoriser une meilleure utilisation des données de prospection par ces spécialistes.

ACKNOWLEDGEMENTS:

I would like to thank the many people who have cooperated in this work including the soils, secretarial and cartographic staff of the Land Resource Research Institute and the Ontario Institute of Pedology. Special thanks are given to Mr. E. Presant, Ontario Institute of Pedology.

INTRODUCTION

This publication concerns interpretations for the recently completed Haldimand-Norfolk Soil survey (Presant et al. 1984). It has been customary for many years to include "engineering sections or interpretations" with Canadian soil survey reports (Pawluk, 1968) and to encourage more effective use by planners and engineers (civil as well as agricultural). In response to requests by the Expert Committee on Soil Survey for improved interpretation methodology, pedotechnical interpretations were proposed. The following demonstrates the application of this approach to a very extensive modern survey.

NATURE OF THE INFORMATION:

A great deal of information is obtained during soil survey and most of it is contained somewhere in the soils report. For reference purposes a requirement exists for better presentation for ready use. This is done in the first instance by separating general information from the detailed. The occasional user may choose to refer only to the general information. For engineering users these terms may also have a different meaning and it is necessary to emphasize that detailed refers to detailed descriptions of (generalized) mapping units. The information usually does not apply to specific sites within any map unit - site information must be obtained separately and in addition to the mapping for specific site applications.

For interpretation purposes a requirement to separately illustrate the type of information needed by engineers as contrasted to planners is recognized. For the former, LANDSCAPE interpretation are provided on the premise that information concerning the landscape and its soil characteristics is required. Access to this information is provided by keys to the map and examples of use.

For planners, LAND USE interpretations are provided on the premise that information concerning the application of soil information to land use planning is the most pressing need. Keys to the map and examples of use are separately given.

KEY TO LANDSCAPE INTERPRETATIONS

This key is to help engineering readers make use of the soils map and report to develop a better understanding of the lie of the land. It consists of a number of tables. Listed alphabetically in the first column of Table 1 are the major map unit component symbols of the map units used in the Haldimand-Norfolk soil survey. The 2nd and 3rd column refer the reader to the general and detailed information respectively. The general information is all given on a single page (Table 2) termed "Landscape setting legends", where each of these map unit components is illustrated. This information is complementary to the general legend of the soil survey map.

The third column of Table 1, refers the user to the detailed information on the pedotechnical settings (Appendix 1). The settings illustrate as closely as possible, the concepts of the central theme of the map unit components. The data does not refer to any particular site nor to modal sites within any delineation, although information may have been obtained from specific sites considered to be typical for the map unit component. Most of these map unit components represent soil series.

EXAMPLE ILLUSTRATING LANDSCAPE INTERPRETATIONS:

(a) General interpretations:

If the symbol LIC occurs in any delineation on the soils map, it infers that the most prevalent soils in that area are likely to be those which are best described by the LIC map unit component. Table 1 lists this map unit component, (LIC refers to the Lincoln soil series) as being illustrated in Legend I on the Landscape Setting Legends (Table 2). Legend I of Table 2 shows that LIC soils illustrated as D on the cross-section diagram, are typical of the poorly drained (P) member of the "D" catena* of soils (SHV, HIM and LIC).

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* Catena - a non taxonomic grouping of a sequence of soils of about the same age, derived from similar parent materials, and occurring under similar climatic conditions, but having unlike characteristics because of variations in relief and in drainage (from AG. CANADA "Glossary of Soil Science terms").

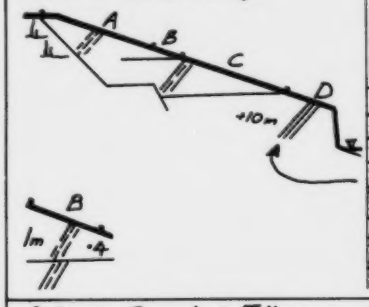
KEY TO LANDSCAPE INTERPRETATIONS

MAP UNIT COMPONENT	LANDSCAPE SETTING LEGEND (Table 2)	PEDOTECHNICAL SETTING SHEET (Appendix 1)
ALU	VII	ALU
BAY	II	FOX
BFO	I	BFO
BOO	V	BOO
BOO.T	IV	BOO.T
BOK	VI	FRM
BRR	V	BOO
BRR.H	V	BRR.H
BRR.T	IV	BOO.T
BRT	I	BRT
BUF	III	BUF
BVY	I	BFO
CWO	I	BRT
FOX	II	FOX
FRM	VI	FRM
GNY	II	FOX
GOB	IV	MUI
HIM	I	SHV
HMP	VIII	SYX
KVN	IV	MUI
LDL	VIII	SYX
LIC	I	SHV
LOW	II	LOW
MPW	I	TVK
MUI	IV	MUI

MAP UNIT COMPONENT	LANDSCAPE SETTING LEGEND (Table 2)	PEDOTECHNICAL SETTING SHEET (Appendix 1)
NDE	II	WAT
NGR	IV	OTI
OKL	III	STD
OTI	IV	OTI
OVW	VIII	SYX
PFD	II	PFD
PFD.D	II	PFD
SHV	I	SHV
SIH	V	WSH
SLI	II	WAT
SNA	III	SNA
STD	III	STD
SYX	VIII	SYX
TVK	I	TVK
TLD	I	BFO
TUC	I	BRT
VIT	V	WSH
VSS	III	STD
WAM	II	PFD
WAT	II	WAT
WIL	III	WIL
WLL	IV	OTI
WRN	II	PFD
WSH	V	WSH
WUS	V	BOO

LANDSCAPE SETTING LEGENDS

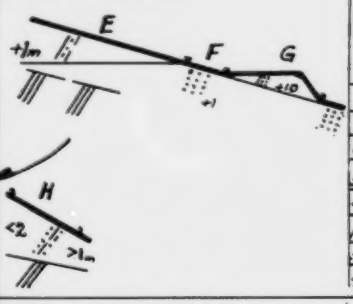
Soils on Silts & Clays:



LEGEND I

X-SECTION	Soil Series drainage W	I	P
A	BART	TUL	CWO
B	–	TEVK	MPN
C	BFO	BVY	TLD
D	SHV	HIN	LIC
	Silts		
	Silty clays		
	Clays		
V	Lake Erie		

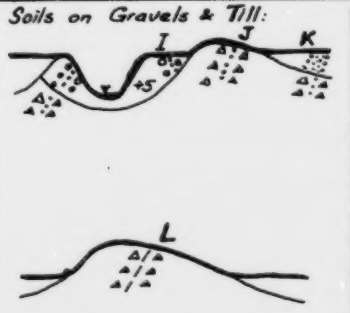
Soils on Sands



LEGEND II

X-SECTION	Soil Series drainage W	I	P
E	WAT	NDE	SLI
F	FOX	BAY	GNY
G	BFD	WAM	WRN
H	–	–	LOW
	Sand (m. to c.)		
	fine sandy loam		
	Sand (f.)		
	loamy fine sand		

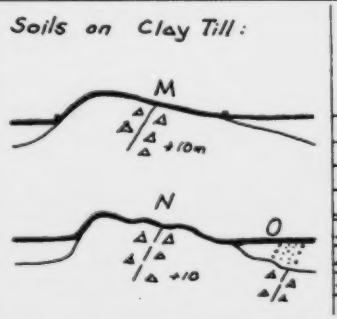
Soils on Gravels & Till:



LEGEND III

X-SECTION	Soil Series drainage W	I	P
I	BUF	–	–
J	WIL	–	–
K	STD	ORL	ISS
L	SNA	–	–
	Gravels		
	Gravel Till		
	Sandy overlay		
	Loam Till		

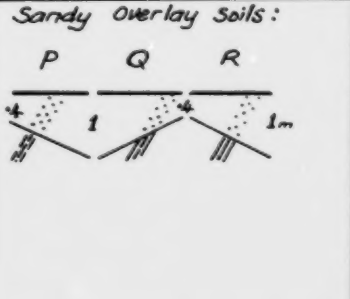
Soils on Clay Till:



LEGEND IV

X-SECTION	Soil Series drainage W	I	P
M	OTI	NGR	WLL
N	MUI	GOB	KVN
O	Bon-T	BOR-T	WIS-T
	Clay Till		
	Clay loam Till		
	Sandy overlay		

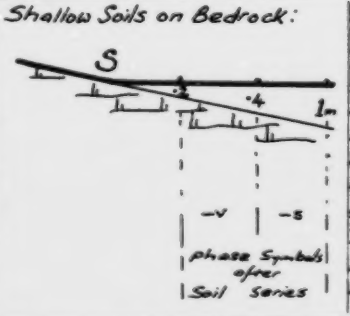
Sandy Overlay Soils:



LEGEND V

X-SECTION	Soil Series drainage W	I	P
P	WSH	VIT	SIN
Q	BOO	BAR	WIS
R	BOO-T	BAR-T	WIS-T
	overlay (c, m, f.)		
	silty soils		
	silty clay		
	clay soils		

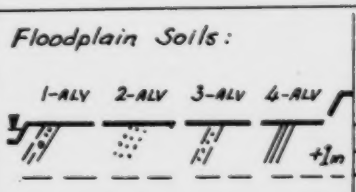
Shallow Soils on Bedrock:



LEGEND VI

X-SECTION	Soil Series drainage W	I	P
S	FRM	–	BOK
	Limestone		
-S	shallow phase		
-V	very " "		

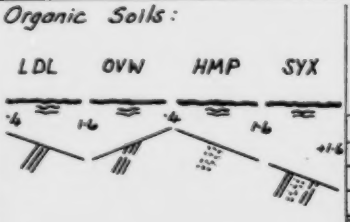
Floodplain Soils:



LEGEND VII

X-SECTION	Soil Series drainage W	I	P
-	1- ALV		
-	2- ALV		
-	3- ALV		
-	4- ALV		
	mixed soils		
	coarse "		
	medium "		
	fine "		

Organic Soils:



LEGEND VIII

X-SECTION	Soil Series drainage W	I	P
-	–	–	LDL
-	–	–	OVW
-	–	–	HMP
-	–	–	SYX
	Organic soil		
	fine mineral "		
	medium " "		
	coarse " "		

The cross-section indicates that this" D" catena of soils comes under the general heading of soils on silts and clays. The D soils have developed on the clay section of this silt-clay landscape sequence. The clays are deep, generally more than 10 meters thick (+10m), typically found on the Haldimand plain north of Lake Erie. The cross-section also shows that this catena of soils merges with soils of the "C" catena (BFO, BVY, TLD) which usually occurs at higher elevations further from the lake, and which have siltier textures; and also with the "A" catena (BRT, TUC, CWO) which has developed on the still coarser, deep silty soils occurring at somewhat higher elevations. It should be noted that the "B" catena constitutes an "overlay" soil where the silts are only between 0.4 and 1 m in thickness over clays. No well drained member was mapped in the "B" catena.

It is possible to use only this general information and make good use of the soil survey map for a variety of purposes. Indeed this is as far as many users may need to go. The soil survey field and laboratory data, however, does provide a considerable amount of additional information. To utilize this more detailed information, reference is then made to the third column of Table 1.

(b) Detailed interpretations:

Referring to Table 1, it is noted that detailed information for the Lincoln (LIC) soils is given in appendix I on P/T setting sheet SHV which applies to all soils in that catena. The standard key to the symbology used on the P/T setting sheets is explained in Pedotechnique (Wilson 1982). But

for the specialist user of this type of information it is possible to illustrate its use more briefly here with the key to the pedotechnical setting sheet (Fig. 1) and also with the example given by the LIC symbol.

Fig. 1 is a blank P/T setting sheet with brief explanatory notes. These notes indicate that the general landscape concept as previously explained, is reproduced as module 1; under the heading "1. LANDSCAPE X-SECTIONS".

Typical soil profiles, landscape position, etc are given in module 2 entitled "2. MAP UNIT COMPONENTS".

The map unit component concepts are further described in terms of grain size distribution, plasticity, etc which are included in module 3, as "3. LAND FACTOR DATA".

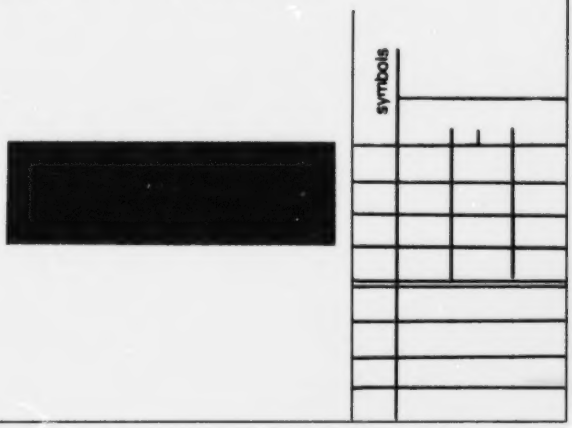
Continuing with the previous example; according to Table 1 the detailed interpretation of the LIC map unit component is given on P/T setting sheet SHV (Appendix I). Module 1 on this sheet again shows that the LIC symbol refers to the poorly drained member of the Smithville (SHV) catena and illustrates the general setting on the landscape as described previously.

Module 2 indicates that this poorly drained (P) condition refers to a position on the landscape (2.2) where gleysolic soils (G) developed on flat lying ground as a result of groundwater table conditions (2.3) in which the piezometric level (∇) in the Bg soil horizon does not drop more than 0.10 to 0.40 m below the ground surface for most of the year except at mid-summer (the ordinate scale is depth, m; the abscissa is a yearly time scale Jan.

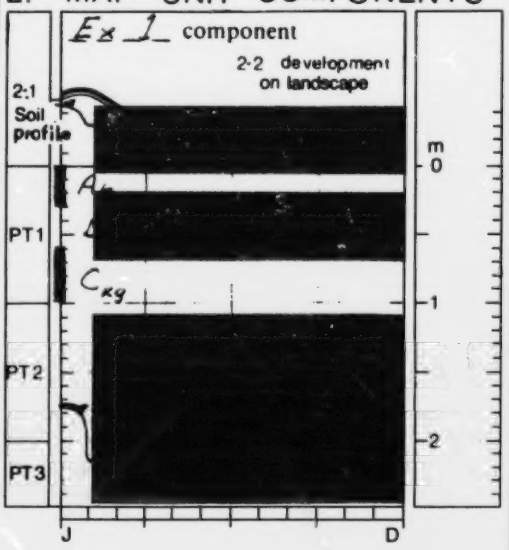
PEDOTECHNICAL SETTING SHEET

Ex 1, Ex 2, Ex 3 _ _ _ map unit components

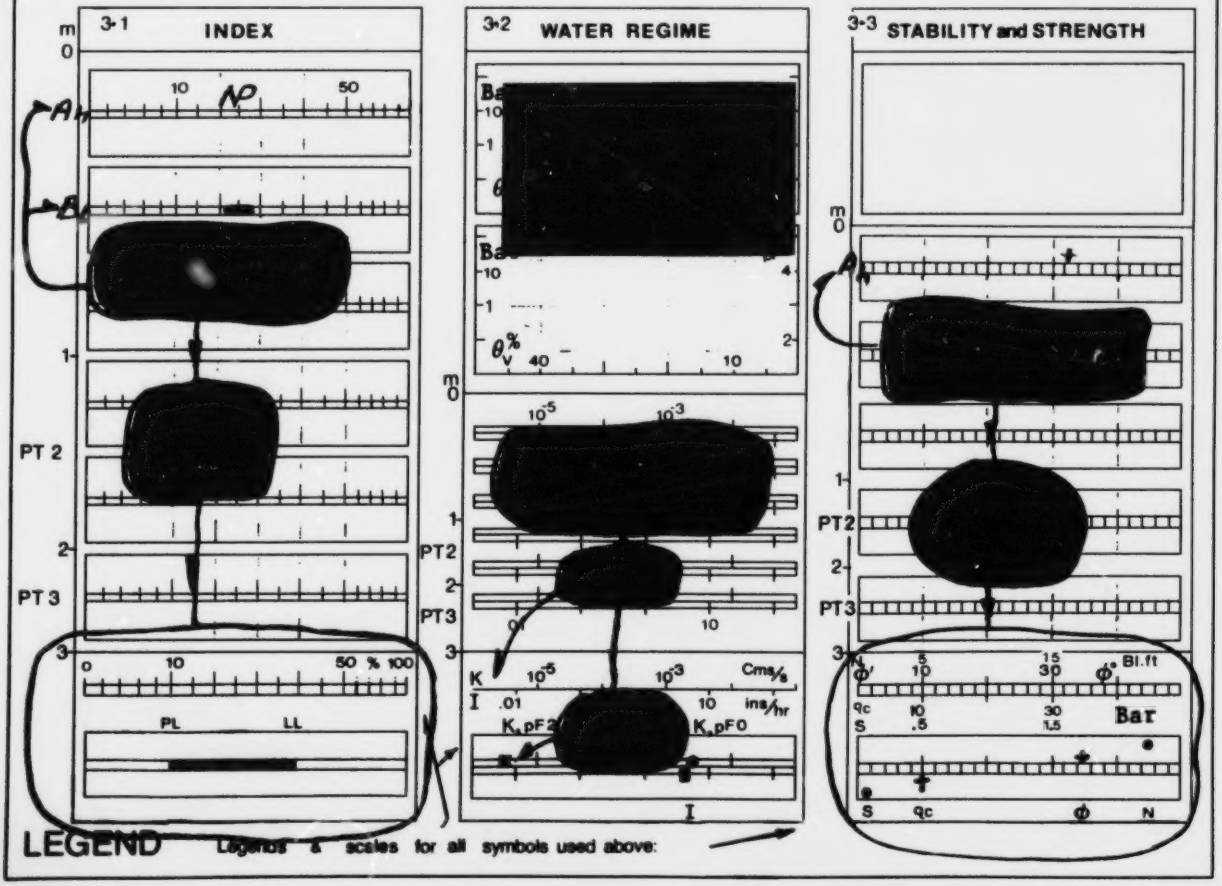
1. LANDSCAPE X-SECTIONS



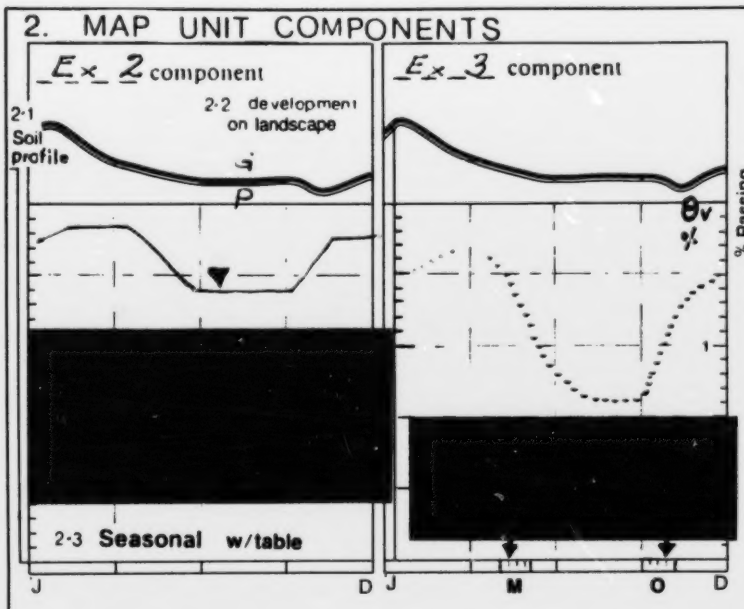
2. MAP UNIT COMPONENTS

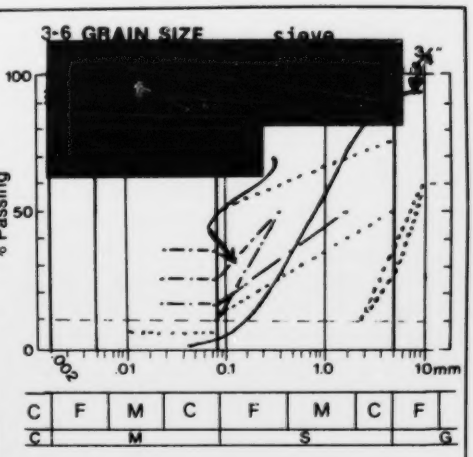


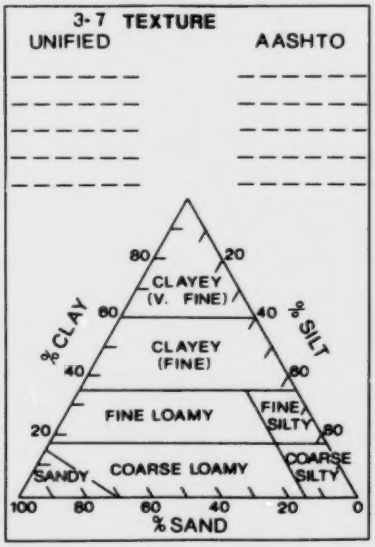
3. LAND FACTOR DATA

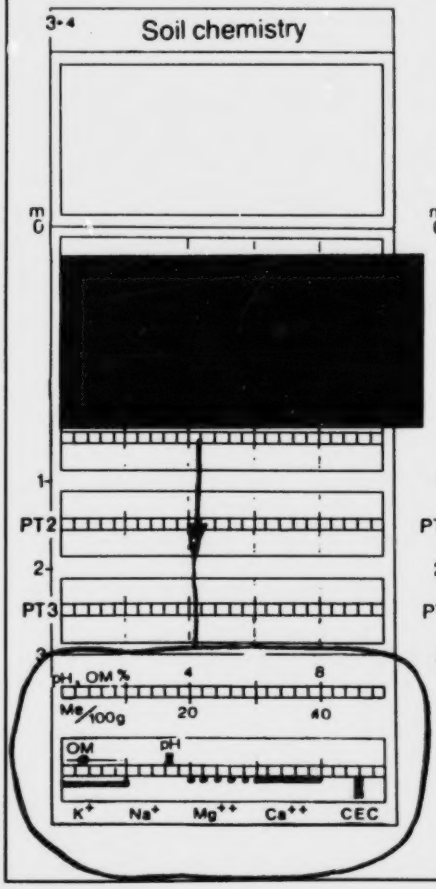


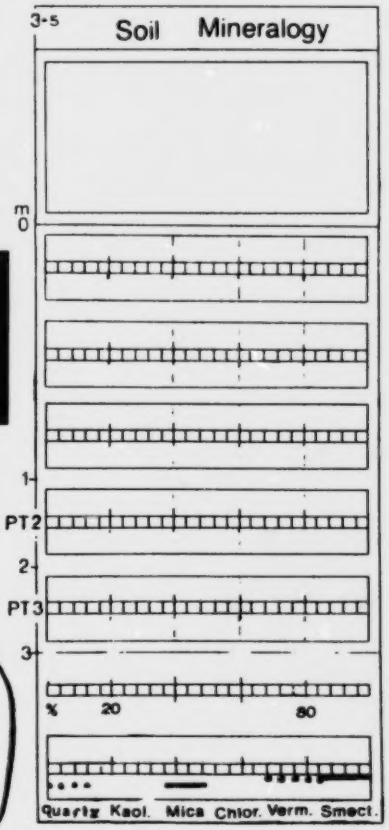
2. MAP UNIT COMPONENTS

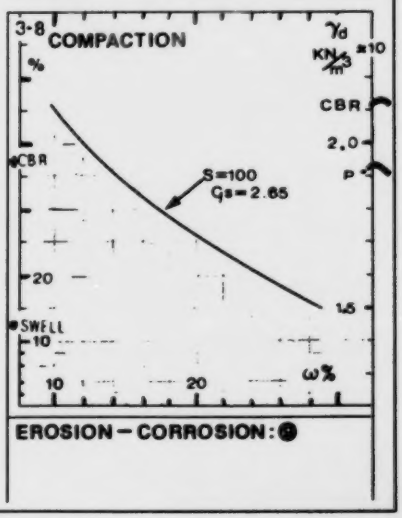












EROSION – CORROSION: ⊖

(J) to Dec. (D)). For the Lincoln soils (LIC), the water table is generally not perched; the piezometric level in the Ckg horizon is somewhat less than it is in the Bg horizon indicating downward movement of ground water throughout the year. The soil profile (2.1) indicates that below the cultivated surface horizon Ap (.20 m thick) there is a gleyed horizon Bg (0.2 m thick), and the parent material horizon Ckg is also gleyed.

The grain size distribution curve, (Module 3.6), shows the Bg and Ckg horizons to be similar, with clay contents around 60% which classify the texture of the soil as clayey or very fine, (Module 3.7).

The index properties shown on Module 3.1 indicate the Ckg horizon to be clay of low plasticity, but with high plasticity characteristics in the Bg horizon (LL 50%); shrinkage limit (SL) just below the PL indicating non-elastic parent material soils; porosity is 35%. Combining this plasticity data with the grain size curves exhibited, and using interpretation sheets (Wilson 1982), the C horizon soils have been classified in the range of CL (Unified) and A-7-6(12) (AASHTO) in Module 3.7. Compaction characteristics (Module 3.8) are normal for silty clay, with CBR (γ_d) values of 1.5 at optimum water content of 27%. The moisture availability is not high (Module 3.2), with 10% available between field capacity (1/10 bar) and wilting point (15 bar). Hydraulic conductivity (K) is very low at less than 1×10^{-6} cm/sec, although infiltration rates (I) have not been measured.

This method of presenting soil survey information sets the stage for its use by other interest groups. A recent example involved specialists concerned with the soil moisture and farm equipment operation. Combining the index, water regime and climatic data the soil moisture analogues and dates for the ground being trafficable 80% of the time were compiled. The method is described, Dyer 1984 and 1985. The analogues are presented on Module 2; the trafficability probability dates (by the arrows) and the soil moisture (by the dotted lines).

APPLICATION OF SOILS INFORMATION

For planning, engineering and other non-biological applications of soil survey, interpretations are normally made for land use purposes, (Soil Survey Staff, 1975). For every project involving a change of land use, the value of prime agricultural land should be considered as a first priority. This does not necessarily imply safeguarding individual cultivated areas but rather maintaining the integrity of larger regions well-suited for commercial agriculture. The Haldimand-Norfolk soil report discusses agricultural interpretations which include land capability and crop suitability ratings. These can be used as a guide to the impact of projects involving land use changes. Other engineering land use interpretations are given below. They include interpretations for land use changes associated with such activities as the extraction of material for construction purposes and the use of the land for building site development. The method used in developing ratings with these interpretations is adopted from procedures

described by Marshall et al. (1979) for agricultural capability. However the intent is quite different and instead of referring to capability, the procedure is termed Land Factor Ratings".

Land Factor Ratings

A major difference of land factor rating from capability rating is that the pedotechnical scheme refers only to specific land factors important for the use considered, whereas capability for agriculture is a comprehensive rating of the land for general agriculture. In considering the suitability for the land for septic tanks for example, the soil survey information could be used for a basic classification because most factors controlling biological filtration in the soil are already encompassed in agricultural capability ratings. But official ratings of the land for the use of septic tank effluent disposal may also require consideration of certain other factors not fully encompassed during the soil survey operations. (eg. the geo-hydrological conditions of specific areas).

Classes and subclasses are used in the land factor rating system as discussed below:

Classes

The classification scheme is comprised of seven (7) classes according to the likelihood of encountering problems (limitations) for the uses being considered. These seven classes provide the user with information about the degree and kind of limitation for broad planning purposes and for assessment

of mitigation measures. These classes are:

Class U1: Land having factors indicative of UNLIKELY soil problems for the use considered.

Classes P2 to P4: Land having factors indicative of POSSIBLE soil problems for the use considered.

Classes L5 to L7: Land having factors indicative of LIKELY soil problems for the use considered.

Subclasses

Subclasses are divisions within classes having similar kinds of limitations or problems. These define the land factor problems for the use.

The list of subclasses given below applies to two interpretations which have been made for this report, namely septic tank absorption fields, and dwelling sites. A third interpretation, location of construction materials, follows this discussion.

Septic Tank Interpretation:

Subclasses Ds - Stony ground affecting tile trench excavation; stoniness above 1m.

Ds' - Stoniness at surface

Dr - Depth to bedrock or hardpan; depth between 1 to 2m.

Dr' - At surface (to 1m)

Dc - Depth to impervious layer; impervious layer between 1 to 2m

Dc' - Impervious layer at surface (to 1m)

Dw - Depth to water table;
water table between 1 and 2m

Dw' - Water table at surface (to 1m)

Nn - Nitrogen attenuation problems due to highly pervious layer between 1 & 2m.

Nn' - Highly pervious layer at surface (to 1m).

Np - Phosphorus retention problems due to lack of fixation sites between 1 and 2 m.

Np' - Inadequate fixation near surface (to 1m).

Ss - Unfavourable land slopes.
Class E slopes: (9-15%)

Ss' - Slopes above Class E (and Class"A" depressional)

Si - Pollution hazard due to inundation by overland flow or very poorly drained soil

Si' - In predicted floodplain area.

Dwellings Interpretation:

Subclass Es - Stones interfering with excavation; stones at less than 1m

Es' - Stones at surface

Er - Excavation problems; Bedrock (or hardpan) between 1 & 2m

Er' - At less than 1m

Ew - Wet excavation problems; unstable soils betweeen 1 & 2m

Ew' - At less than 1m

Fb - Flooding basement hazard; wet pervious zone, between 1 & 2m

Fb' - At less than 1m

Fi - Inundation of land; by overland flow (very poorly drained)

Fi' - Within floodplain

Hf - Hazard due to frost heave; susceptible soils between 1 & 2m

Hf' - From surface to 1m

Hc - Hazard due to swelling clays; susceptible soils from surface to 2m

Hc' - From 2 to 3m

Hr - Hazard due to expansive rock; susceptible rock between 1 & 2m

Hr' - From surface to 1m

Sb - Hazard due to differential settlement; weak soil within 4m

Sb' - Very weak soils within 4m

So - Hazard due to organic soil subsidence; soils with peaty phases

So' - Organic soils

St - Hazard due to soil shrinkage; borderline soils within 4m

St' - Shrinkable soils within 4m

Construction Materials Interpretation:

A similar procedure can be used to indicate the "potential of a soil for a use" rather than limitations for a use. This was done for interpreting the suitability of various soils for construction materials. In this instance the land factor classes are defined as follows:

Class UI : Unlikely potential for location of construction materials.

Classes P2 to P4 : Possible potential for location of construction materials.

Classes L5 to L7 : Likely potential for location of construction materials.

Subclass F - Potential sources of roadfill; thickness more than 1m (with less than 1m overburden);

F' - More than 2m in thickness

G or S - Potential sources of sand(S) or gravel (G); more than 1m (with less than 1m overburden)

S' or G' - More than 2m in thickness

R - Potential sources of rockfill (R); bedrock, with between 1 & 2m overburden

R' - Bedrock, with less than 1m overburden

Guidelines Used in the Rating Scheme:

The land factor classification is developed for components of soil map units for which the relevant land factors are identified and separated. The pedotechnical setting sheet permits the central concept of the various soil series, soil phases and miscellaneous land units (soil map unit components) to be identified in terms of land factors such as grain size and compaction characteristics of the soil, etc. A number of specific problems to which the land factors relate are identified for each interpretation. Interpretation sheets (Appendix II) illustrate these problems and provide tables to obtain the subclasses, using the setting sheet as the source of information. The subclasses are grouped according to their combined potential or limitation for the particular land use considered.

The example given below is for the septic tank interpretation. The use of the land for disposal of septic tank effluents is seen as a pollution problem and three specific problems are identified. Land factors are grouped according to these basic problems:

I/ Limitations due to depth limits (D) which define the boundaries of the soil as an effective biological filter.

II/ Limitations due to the degree to which the biological filter (soil) is effective for nutrient attenuation (N).

III/ Limitations due to the setting (S) of the mapping unit on the landscape relative to potential pollution hazards.

Interpretation Sheets D, N and S (Appendix II) permit land factor subclasses (as previously listed) to be determined from the setting sheets for each map unit component. For example on interpretation sheet "D", (Fig. 2), it is seen that the problem has been interpreted in terms of the mitigation measures required to correct the deficiency. The extra amount of fill required to bring the land to an acceptable standard for this land use, provides a rating in quantitative terms. For the 'D' sheet these ratings are:

UNLIKELY - no extra fill required;

POSSIBLE - up to 1m of fill required;

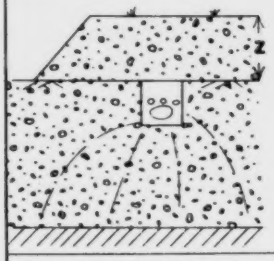
LIKELY - more than 1m of fill required.

INTERPRETATION

SEPTIC TANKS

SOIL PROBLEMS DUE TO

DEPTH OF SOIL FILTER, D

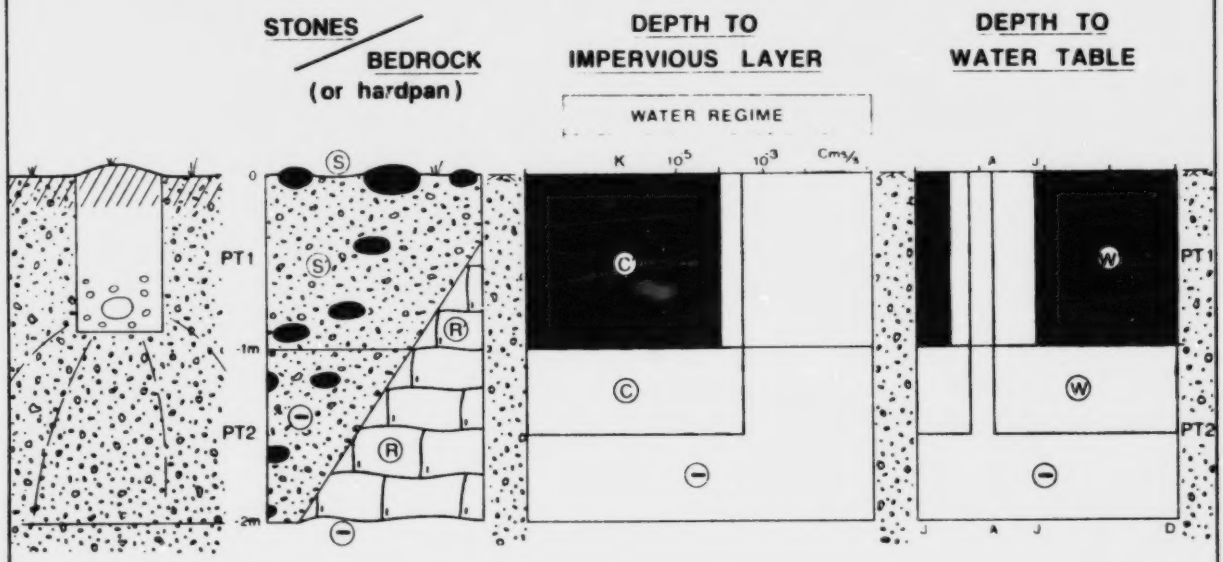


PROBLEM

Extra Filter (z) Required

FACTORS CONSIDERED

Depth to Bedrock (and hardpan) ——— Dr
Presence of Stones ——— Ds
Depth to Impervious Layer ——— Dc
Depth to Water Table ——— Dw



INTERPRETATION

PROBLEM CLASS	STONES in PT1 layer		BEDROCK AND HARDPAN		IMPERVIOUS LAYER		WATER TABLE	
UNLIKELY	below PT1	–	below PT2 ⊖	–	zone ⊖	–	within zone ⊖	–
POSSIBLE	at surface only (S)	Ds	in PT2 only (R)	Dr	zone (C)	Dc	within zone (W)	Dw
LIKELY	in PT1 (S′)	Ds′	in PT1 (R′)	Dr′	within zone (C′)	Dc′	within zone (W′)	Dw′

Interpretation (Septic Tanks) (Sheet D)

The different land factors contributing to this depth deficiency are listed as the presence of stones (s), the presence of bedrock or hardpan (r), the presence of an impervious layer (c), and the presence of a high water table condition (w). The method of rating is to compare the information on the appropriate module of the setting sheet with that of the interpretation sheet. On the interpretation sheet (D), the column entitled "Depth to impervious layer", shows 3 envelopes; one with the symbol ("C", one with the symbol "C" and another with the symbol "-"). The C' symbol indicates that any soil between the ground surface and a depth of 1m (i.e. the PT 1 layer), which has a K value of 10^{-4} cm/sec or less (i.e. an infiltration rate of less than 0.5 in./hr) is given the LIKELY rating, Dc' for the land factor C (presence of impervious layer at shallow depth). A borderline condition is recognized for soils with infiltration rates between 1" and 0.5 in./hr in the top metre. The borderline (POSSIBLE) rating, Dc is also given for soils with infiltration rates less than 0.5 in./hr but which are between 1m and 2m below the ground surface. For all other conditions the UNLIKELY rating "-" applies.

The soil unit components of the Haldimand-Norfolk Region were classified into seven (7) land factor classes following the procedure described. This provides for a ranking of the map components according to the severity of the problem. The scheme in detail is shown below;

LAND FACTOR CLASS		INTERPRETATION
SEPTIC TANKS		
UI	-	Pollution problems unlikely: mitigation methods should not be required.
P2	-	Possible problems due to depth (Ds, Dr, Dc, Dw): mitigation may require < 1m of fill.
P3	-	Possible problems due to nutrients (Nn, Np); further investigation is required.
P4	-	Possible problems due to setting (Ss, Si); mitigation may require design modifications.
L5	-	Likely problems due to depth (Ds', Dr', Dc', Dw'); mitigation should require > 1m of fill.
L6	-	Likely problems due to nutrients (Nn', Np'); mitigation should require special construction methods.
L7	-	Likely problems due to setting (Ss', Si'); serious problems not likely to be mitigated.

KEY TO LAND USE INTERPRETATIONS:

The key to general land use interpretations is given on Table 4. It illustrates how the reader can make use of the rating symbols given in Table 3, for interpretation purposes. The LIC map unit component is used for the illustration; the rating for septic tanks for this map unit component is obtained from Table 3 as L5Dc'w' (column 2). The most general interpretation of this symbol, Table 4 is shown to be that pollution problems are LIKELY (L) to result if septic tanks are used on this type of land. This is the most general level of the land use interpretations and it may be as far as many users of this information need to go.

It is possible however, to progress beyond this as shown on Table 5 which provides the key to detailed land use interpretations. The rating L5Dc'w' could also denote that the land factors contributing to this rating are due specifically to the lack of sufficient depth (D) of aerated soil due to the presence at shallow depth of an impervious layer (c') and the water table (w'). It is further implied that the problem could be mitigated, but this could require the addition of more than 1m of pervious fill. Table 3 lists the map unit components and their ratings for the 3 land use changes considered i.e. septic tanks, dwelling sites and extraction of construction materials.

TABLE 3

PEDOTECHNICAL LAND FACTOR RATINGS

MAP UNIT COMPONENT	SEPTIC TANKS			DWELLING SITES	CONSTRUCTION MATERIALS
	Slope Classes*			Slope Classes*	
	Aa to Dd	Ee	Ff to Gg	Aa to Gg	Aa to Gg
①	②	③	④	⑤	⑥
1 ALU	L7.Dw'Si'	-	-	L7.EwFl'Sb	U1.
2 ALU	L7.DwNn'Si'	-	-	L7.EwFl'	P3.FS
3 ALU	L7.Si'	-	-	L7.Fl'HfSb	P2.F
4 ALU	L7.Dc'Si'	-	-	L7.Fl'HfSb	U1.
BAY	L5.Dw'Nn	-	-	L7.Ew'Fb'Sb	L6.F'S'
BFO	P2.Dc	P4.Ss	L7.Ds'	P4.HfSb	U1.
BOO	P2.Dc	P4.DcSs	L7.DcSs'	P4.Sb	U1.
BOO.T	P2.Dc	P4.DcSs	L7.DcSs'	P4.Sb	L5.F'
BOK	L5.Dr'	-	-	L5.Er'	P4.R
BRR	L5.Dc'w'	-	-	L7.HfSbFb'	U1.
BRR.H	L5.Dc'w	-	-	L7.EwFb'.Sb	U1.
BRR.T	L5.Dc'w'	-	-	P4.HfSb	P2.F
BRT	P2.Dc	P4.DcSs	L7.DcSs'	P4.Sb	L5.F'
BUF	L6.Nn'	L6.Nn'Ss	L7.Nn'Ss'	U1.	L6.F'G'
BVY	L5.Dw'	-	-	L7.Fb'HfSb	U1.
CWO	L5.Dcw'	-	-	L7.EwFb'	P2.F
FOX	P3.Nn	P4.Ss'	L7.Ss'	P4.Sb	L6.F'S
FRM	L5.Dr'	L5.Dr'Ss	L7.Dr'Ss'	L5.Er'	L7.R'
GNY	L5.Dw'Nn	-	-	L7.Ew'Fb'Sb	L6.F'S
GOB	L5.Dc'w'	-	-	P4.HfSb	U1.
HIM	L5.Dc'w'	-	-	P4.HfSb	U1.
HMP	L7.Si'	-	-	L7.Fl'	U1.
KVN	L5.Dc'w'	-	-	P4.HfSbFb	U1.
LDL	L7.Si'	-	-	L7.Fl'	U1.
LIC	L5.Dc'w'	-	-	P4.HfSb	U1.
LOW	L6.Dw'Nn'	-	-	L7.Ew'Fb'Sb	P3.FS
MPW	L5.Dc'w'	-	-	P4.HfSbFb	U1.

* See Table 4

TABLE 3 (cont.)

PEDOTECHNICAL LAND FACTOR RATINGS

MAP UNIT COMPONENT	SEPTIC TANKS			DWELLING SITES	CONSTRUCTION MATERIALS
	Slope Classes*			Slope Classes*	
	Aa to Dd	Ee	Ff to Gg	Aa to Gg	Aa to Gg
①	②	③	④	⑤	⑥
MUI	L5.Dc'	L5.Dc'Ss	L7.Dc'Ss'	P4.Sb	U1.
NDE	L5.Dw'Nn	-	-	L7.Ew'Fb'	L5.F'S
NGR	L5.Dc'w'	-	-	P4.HfSb	U1.
OKL	L5.Dw'	-	-	P4.HfSb	L5.F'
OTI	L5.Dc'	L5.Dc'Ss	L7.Dc'Ss'	P4.Sb	U1.
OVW	L7.Sl'	-	-	L7.Fl'	U1.
PFD	P3.Nn	P4.NnSs	L7.NnSs'	P4.Sb	P3.FS
PFD.D	P3.Nn	P4.NnSs	L7.NnSs'	P4.Sb	P3.FS
SHV	L5.Dc'	L5.Dc'Ss	L7.Dc'Ss'	P4.Sb	U1.
SIH	L5.Dc'w'	-	-	L7.Ew'HfFb'	P2.F
SLI	L5.Dw'Nn	-	-	L7.Ew'Fb'	L5.F'S
SNA	U1.	P4.DsSs	L7.DsSs'	P4.Sb	P2.F
SYX	L7.Sl'	-	-	L7.Fl'	U1.
TVK	L5.Dc'w'	-	-	P4.HfSb	U1.
TLD	L5.Dw'	-	-	L7.Fb'HfSb	U1.
TUC	L5.Dc'w'	-	-	P4.HfSb	L5.F'
STD	U1.	P4.DcSs	L7.DcSs'	P4.Sb	L5.F'
VIT	L5.Dc'w'	-	-	L7.Ew'HfFb'	P2.F
VSS	L5.Dw'	-	-	P4.HfSb	P2.F
WAM	L5.NnDw'	-	-	L7.Ew'Fb'Sb	P3.FS
WAT	P3.Nn	P4.NnSs	L7.NnSs'	P4.Sb	L5.F'S
WIL	P3.Dc	P4.DcSs	L7.DcSs'	U1.	L5.F'
WLL	L5.Dc'w'	-	-	P4.HfSb	U1.
WRN	L5.Dw'Nn	-	-	L7.Ew'Fb'Sb	P3.FS
WSH	L5.Dc'	L5.Dc'Ss	L7.Dc'Ss'	P4.Sb	P2.F
WUS	L5.Dc'w'	-	-	L7.HfFb'	U1.
WUS.T	L5.Dc'w'	-	-	L7.HfFb'	P2.F

*See Table 4

TABLE 4

KEY TO LAND USE INTERPRETATIONS

GENERAL:

LAND FACTOR RATING	INTERPRETATION
SEPTIC TANKS AND DWELLINGS	
U1.	unlikely soil problems
P2. ..... etc	possible soil problems, as detailed (Table 5)
P3.	
P4.	
L5.	likely soil problems
L6.	
L7.	
CONSTRUCTION MATERIALS	
U1.	unlikely location for resource materials
P2. ..... etc	possible location resource materials (Table 5)
P3.	
P4.	
L5.	likely location
L6.	
L7.	

*Note on Slope Classes:

Simple	%	Complex
A to D	0 to 9	a to d
E	10 to 15	e
F to G	16+	f to g

TABLE 5

KEY TO LAND USE INTERPRETATIONS

DETAILED:

LAND FACTOR RATING	INTERPRETATION		
SEPTIC TANKS	problem	detail	
U1.	—		
P2.DsDcDwDr	shallow depth.....D	s - stoney soil c - impervious soil	w - water table r - bedrock
P3.NnNp	nutrient attenuation.....N	n - nitrogen	p - phosphorous
P4.SsSi	unfavourable setting.....S	s - land slope	i - inundation
L5.Ds'Dw'Dc'Dr'	.....	.....	
L6.Nn'Np'	..... as above	..... as above	
L7.Ss'Si'	.....	.....	
DWELLINGS			
U1.	—		
P2.EsErEw	difficult excavation.....E	s - stoney soil r - bedrock	w - water table
P3.HfHcHr	ground heave.....H	f - frost c - swelling clay	r - swelling rock
P4.SoSbStFbFl	settlement.....S flooding.....F	o - organic soil b - weak soil t - shrinkable soil	b - basement flood i - inundation
L5.Es'Er'Ew'	.....	.....	
L6.Hf'Hc'Hr'	..... as above	..... as above	
L7.So'Sb'St'Fb'Fl'	.....	.....	
CONSTRUCTION MATERIALS	resource material		
U1.	—		
P2.F	roadfill.....F		
P3.SG	sand.....S gravel.....G		
P4.R	rock.....R		
L5.F'	.....		
L6.S'G'	..... as above		
L7.R'	.....		

*see also Guidelines

EXAMPLE ILLUSTRATING LAND USE INTERPRETATIONS:

If the symbol LIC occurs in any delineation on the soil map, it infers that the most prevalent soils in that area are likely to be those best described by the LIC map unit component. Table 3 gives, for this map unit component, the ratings L5Dc'w', P4HfSb and UI for land use changes due to installation of septic tanks, dwelling sites and extraction of construction materials, respectively. These ratings can be generalized by considering only the first letter i.e. L, P and U. As indicated in Table 4, these symbols can be interpreted as indicating severe pollution problems to be likely (L) if septic tanks were used without strict control at dwelling sites where soil problems (P) could occur , suggesting the land is only moderately suited for this purpose. The land is unlikely to be a resource for construction materials (U). Thus it might be better to leave such land in agriculture since it is generally unsuitable for septic tanks or construction materials. However if dwelling sites were to be seriously considered, it would be advisable to have soils experts report on septic tank waste disposal systems and to carry out tests on the soils, especially the deeper soils, to verify their competence for building foundations.

If two components are included in a map unit e.g. LIC (Lincoln) and FRM (Farmington), in approximate proportions of 70:30, the above remarks would only apply to the soils occupying about 70% of the area. For the remaining 30% of FRM soils, Table 3 (map unit component FRM) would indicate L5, L5 and L7 for the same uses. Similar remarks as given above for the LIC symbol might apply to the use of septic tanks and dwellings for this other type of land, but for different reasons. There could also be possible land use conflicts with quarry operations (L7), but little conflict with agriculture (agricultural capability would only be rated as Class 6).

HOW TO USE THIS PUBLICATION

If the reader is only interested in the general role of the Haldimand-Norfolk soils map in planning or for similar regional problems, reference could be made directly to the section explaining the (key to land use interpretations) and to Table 3.

If on the other hand the reader is only interested in obtaining a general appreciation and understanding of the soils in the area, reference could be made directly to the section explaining the (landscape interpretations) and to Table 2. For these purposes it should be noted that the information given applies to the entire area delineated and not to any particular site within these delineations.

Users interested in developing a working knowledge of the soils and an ability to efficiently use the soils map would be advised to consider both

sections of this publication and also to consult the Haldimand-Norfolk soil survey report. Finally it may be said that there are also other survey records, (geological, hydrological, ground water, terrain analysis and others) from provincial, federal and private agencies which should be consulted for a full appreciation of the land resources of this region.

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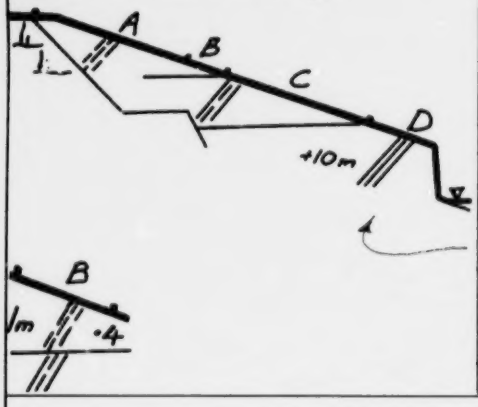
Wilson, G. 1983. Interpretation Sheets for Engineering Classifications in Soil Surveys. Can. J. Soil Sci. 63: 679-689.

PEDOTECHNICAL SETTING SHEET

SHV, HIM, LIC – – – map unit components

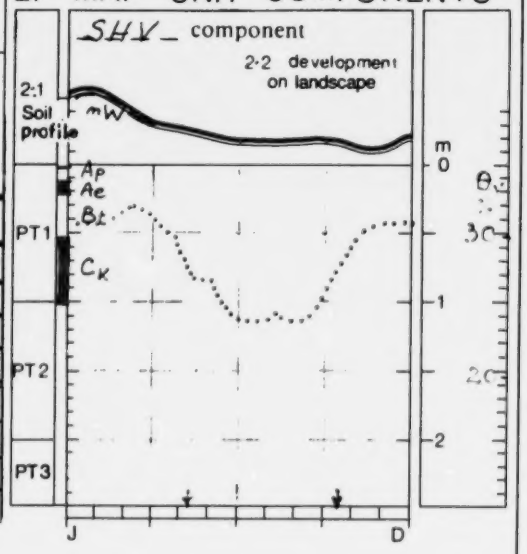
1. LANDSCAPE X-SECTIONS

Soils on Silts & Clays:

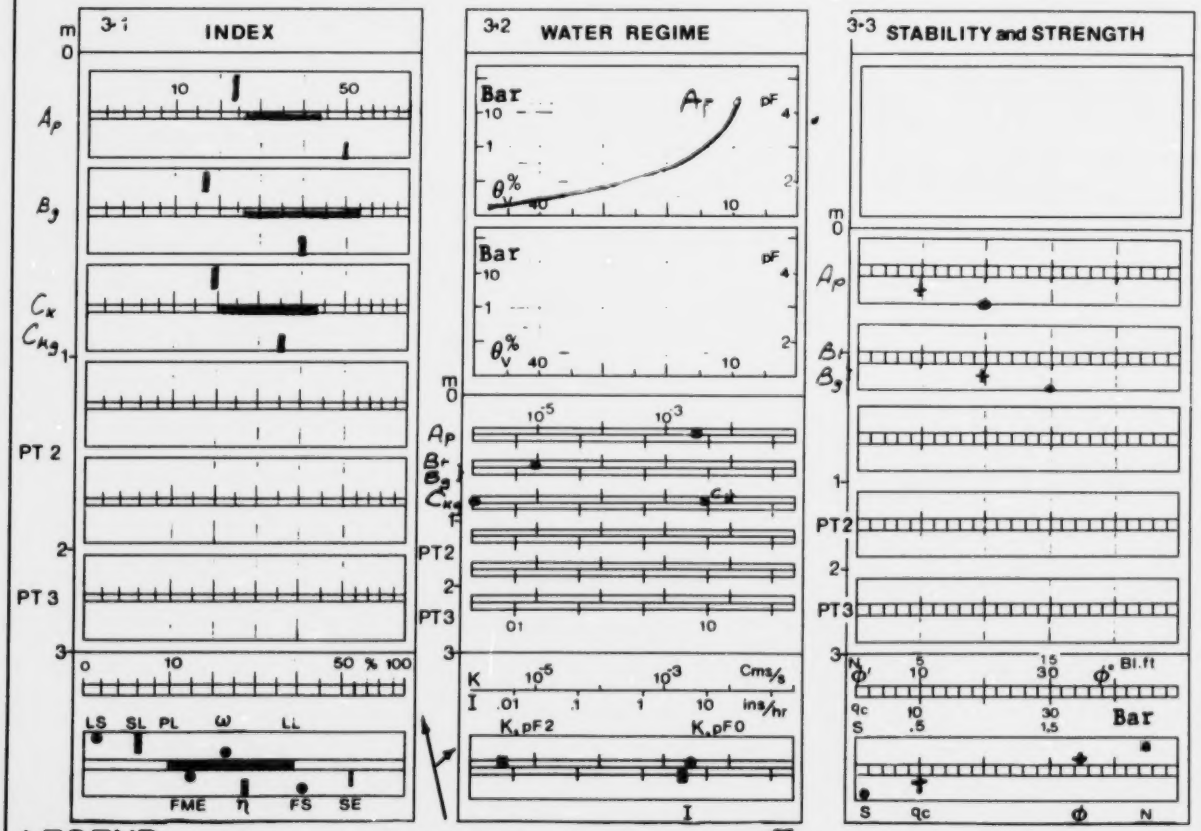


X-SECTION symbols	LEGEND map unit components	drainage W	I	P
A		BRT	TUC	CWO
B		–	TVK	MPW
C		BFO	BVY	TLD
D		SHV	HIM	LIC
///	Silts			
///	Silty clays			
///	Clays			
V	Lake Erie			

2. MAP UNIT COMPONENTS

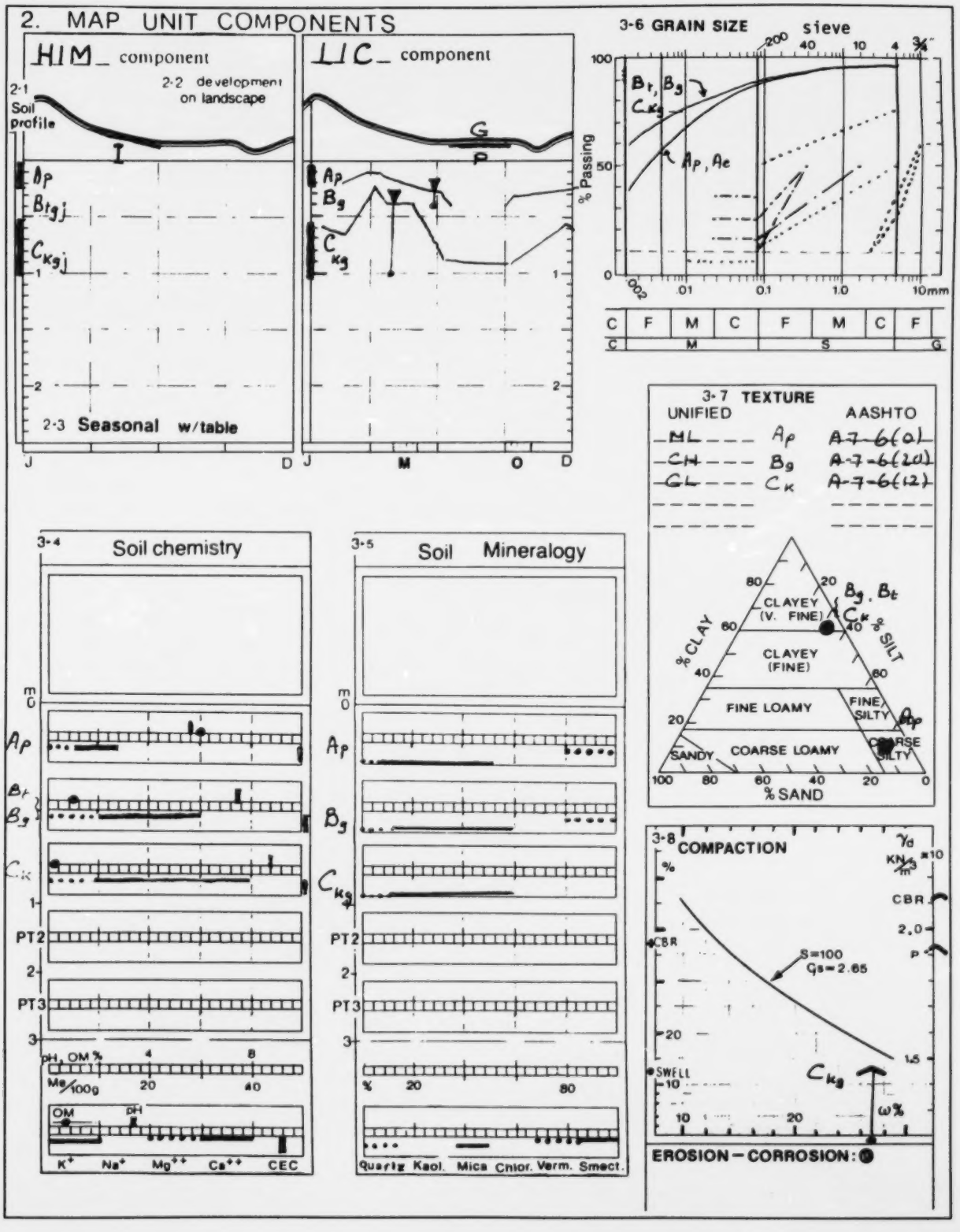


3. LAND FACTOR DATA



LEGEND Legends & scales for all symbols used above:

2. MAP UNIT COMPONENTS

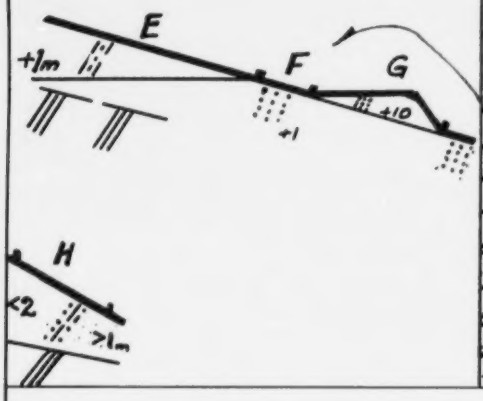


PEDOTECHNICAL SETTING SHEET

FOX, BAY, GNY ___ map unit components

1. LANDSCAPE X-SECTIONS

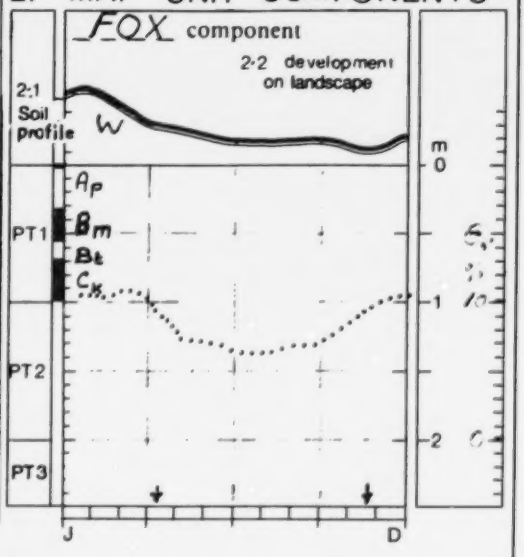
Soils on Sands



LEGEND map unit components

X-SECTION symbol	drainage W	I	P
E	WAT	NDE	SLI
F	FOX	BAY	GNY
G	PFD	WAM	WRN
H	–	–	LOW
Sand (m. to c.)			
fine sandy loam			
sand (f.)			
loamy fine sand			

2. MAP UNIT COMPONENTS



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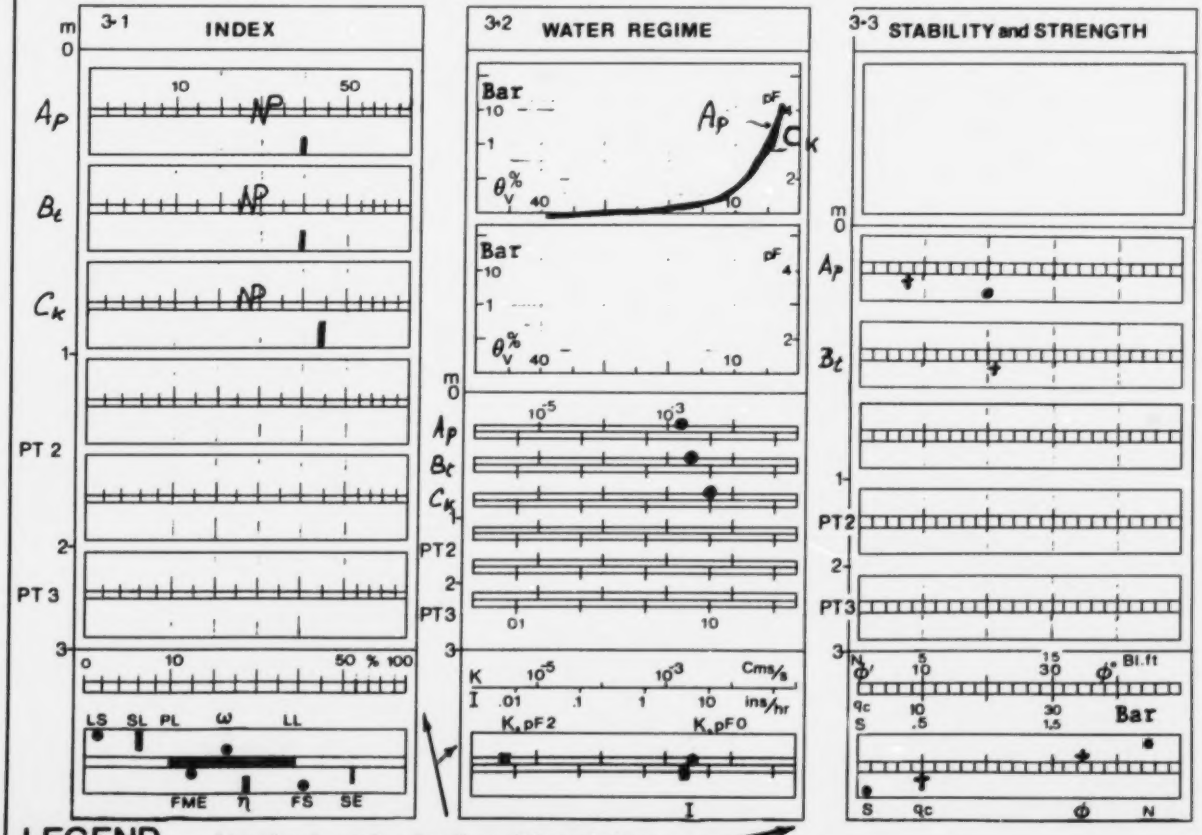
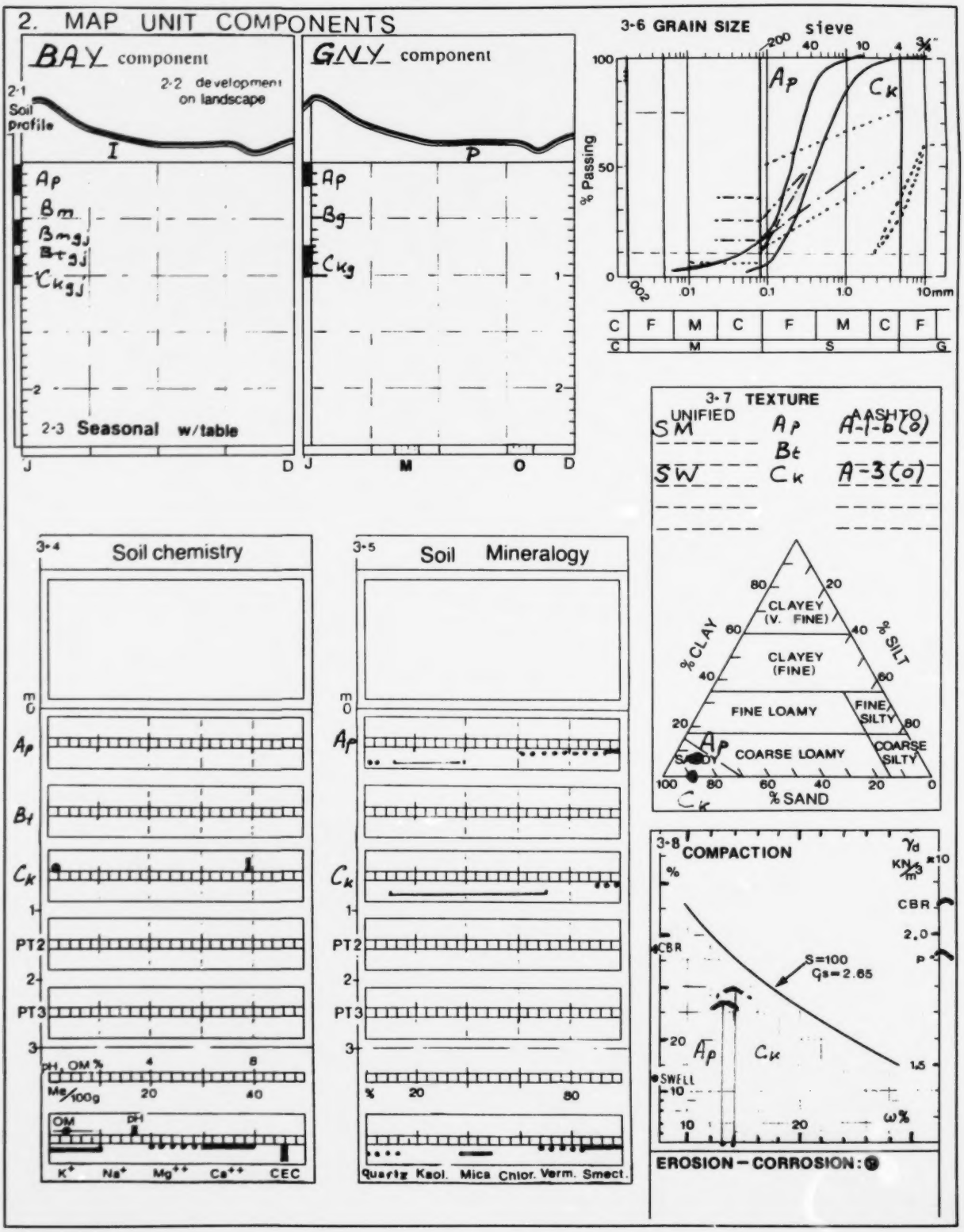


LEGEND Legends & scales for all symbols used above:

2. MAP UNIT COMPONENTS

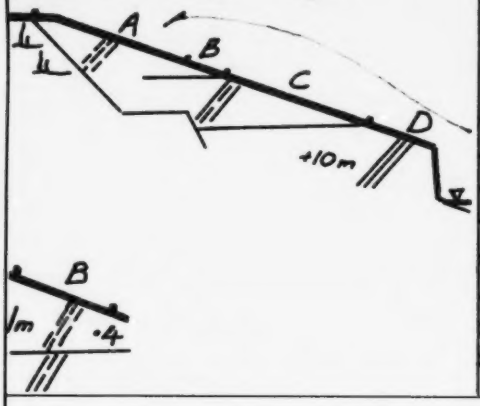


PEDOTECHNICAL SETTING SHEET

BRT, - TUC, CWO - map unit components

1. LANDSCAPE X-SECTIONS

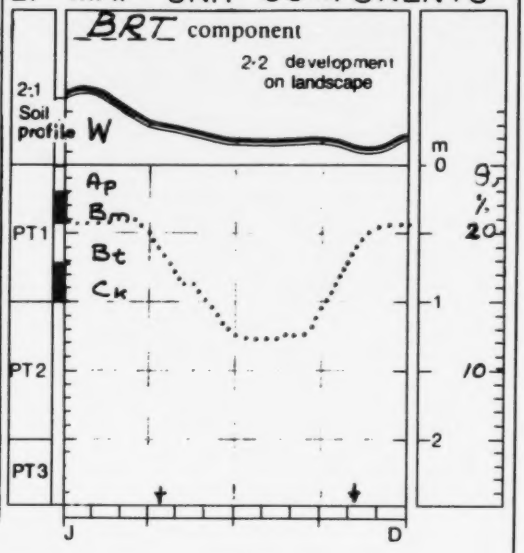
Soils on Silts & Clays:



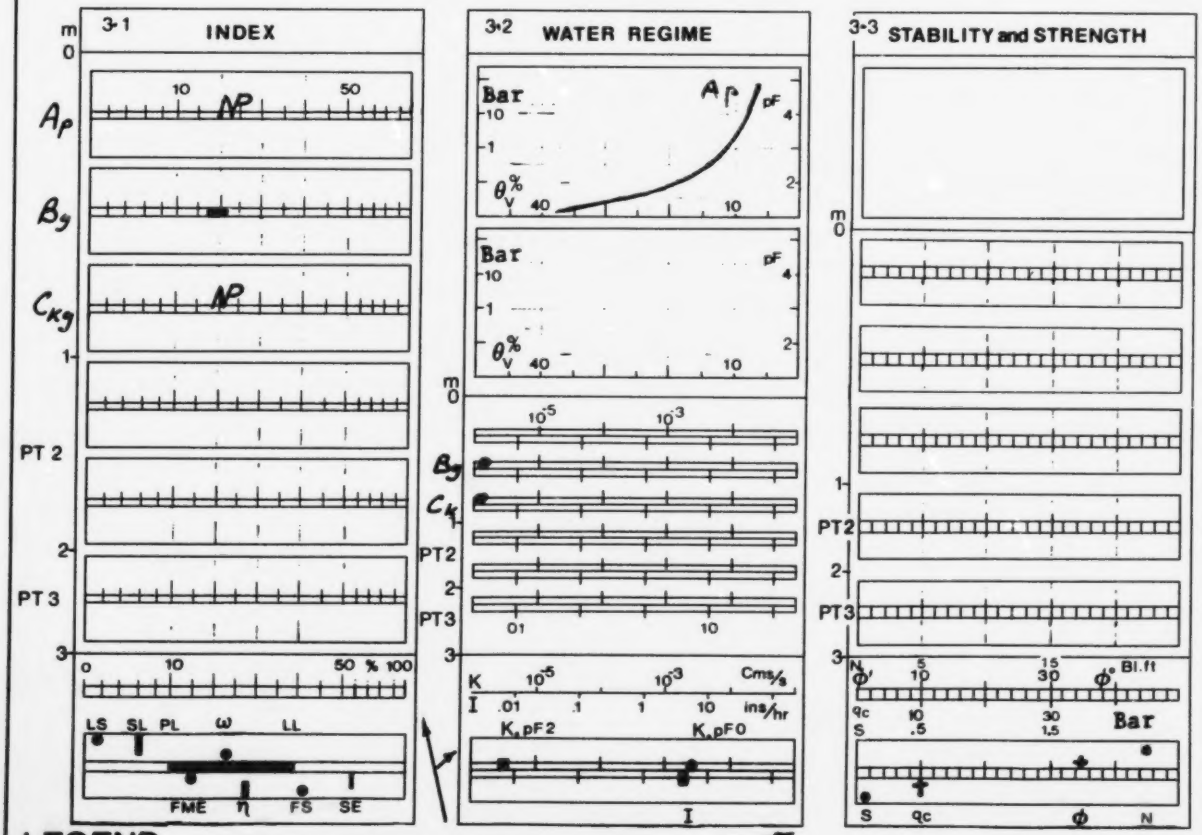
LEGEND — map unit components

X-SECTION symbols	drainage W		P
A	BRT	TUC	CWO
B	–	TVK	MPW
C	MW BFO	BVY	TLD
D	MW SHV	HIM	LIC
///	Silts		
///	Silty clays		
///	Clays		
V	Lake Erie		

2. MAP UNIT COMPONENTS

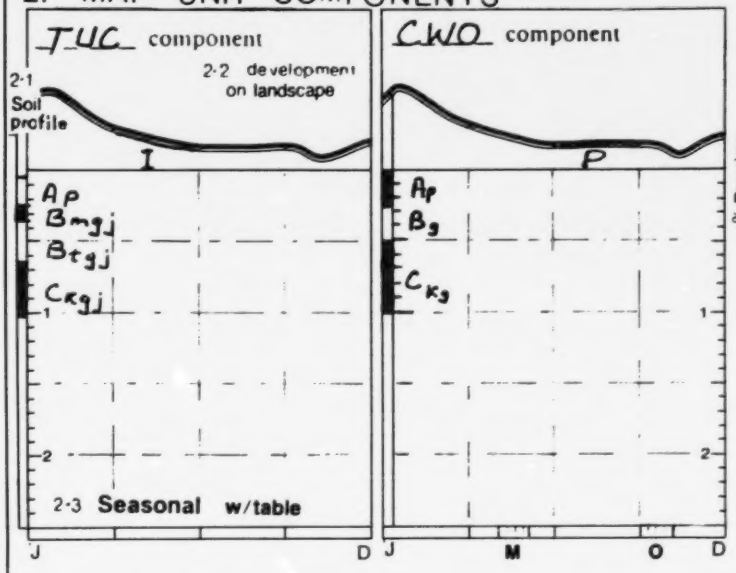


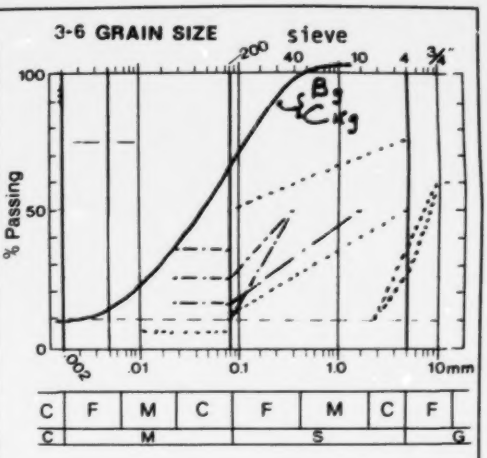
3. LAND FACTOR DATA

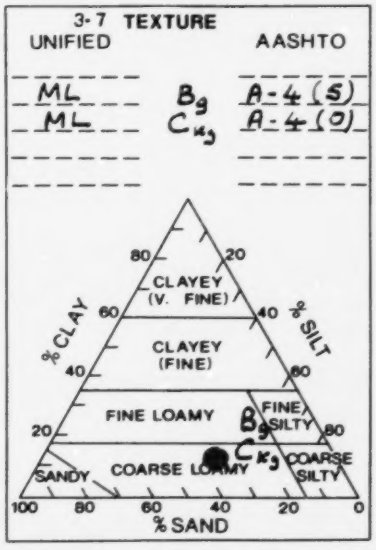


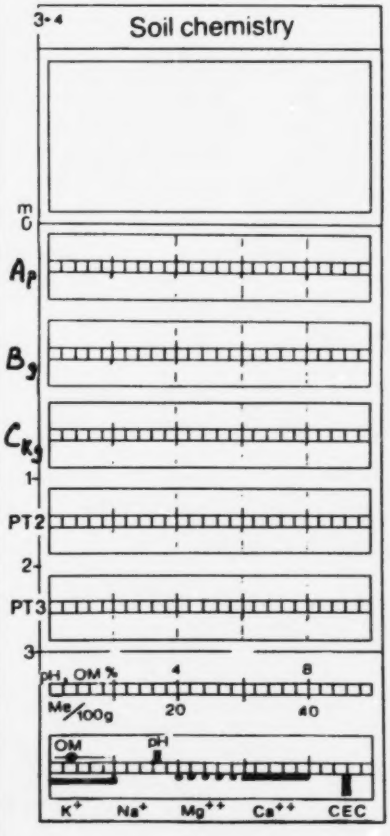
LEGEND Legends & scales for all symbols used above:

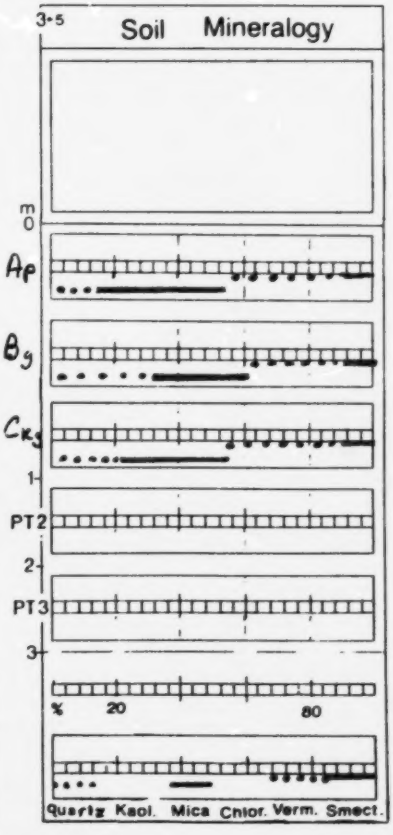
2. MAP UNIT COMPONENTS

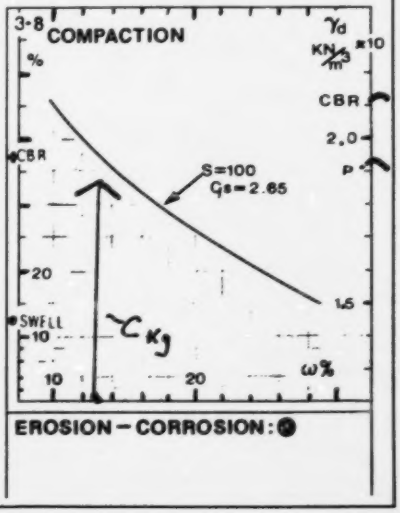










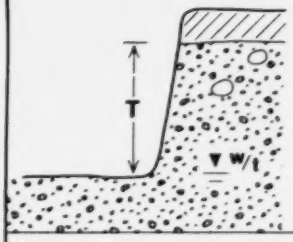


EROSION – CORROSION: ⓪

INTERPRETATION

RESOURCE MATERIALS

LAND AS A POTENTIAL RESOURCE,



FACTORS

Thickness
W/Table
Texture
Stones

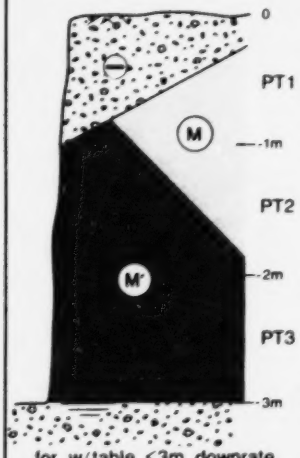
TYPE OF MATERIALS

Gravel (or sand) ——— G (S)

Road Fill ——— F

Rock Fill ——— R

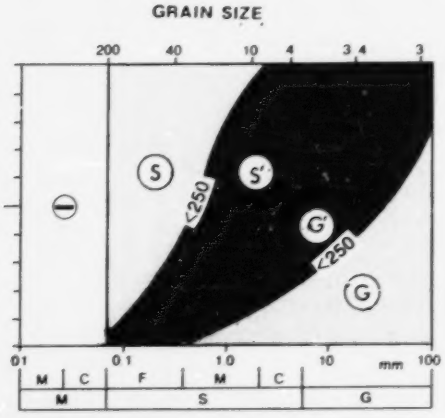
THICKNESS and w/table



for w/table <3m downrate

Ⓖ to Ⓖ

GRAVEL (or sand)

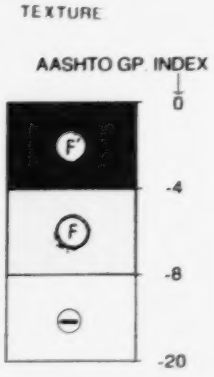


For Stones (>100 mm) 10% to 50% downrate

Ⓖ' to Ⓖ

(*DHO. Gran. "C" Petrog. No<250)

ROAD FILL



RESOURCE CLASS	GRAVEL (and sand)		ROAD FILL		ROCK FILL	
UNLIKELY	Thickness ⊖ or Texture ⊖	–	Thickness ⊖ or AASHTO ⊖	–	Rock below PT2	–
POSSIBLE	Thickness Ⓜ Texture Ⓖ or Ⓖ'	G(S)	Thickness Ⓜ AASHTO Ⓕ or Ⓕ'	F	Rock in PT2 (limestone, L) (sstne, S)	R
LIKELY	Thickness Ⓜ' Texture Ⓖ'	G'(S')	Thickness Ⓜ' AASHTO Ⓕ'	F'	Rock in PT1 (Granite, g) (Shale, h)	R'

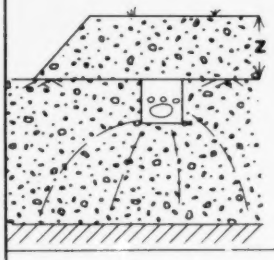
Interpretation (Resource Materials)

INTERPRETATION

SEPTIC TANKS

SOIL PROBLEMS DUE TO

DEPTH OF SOIL FILTER, D

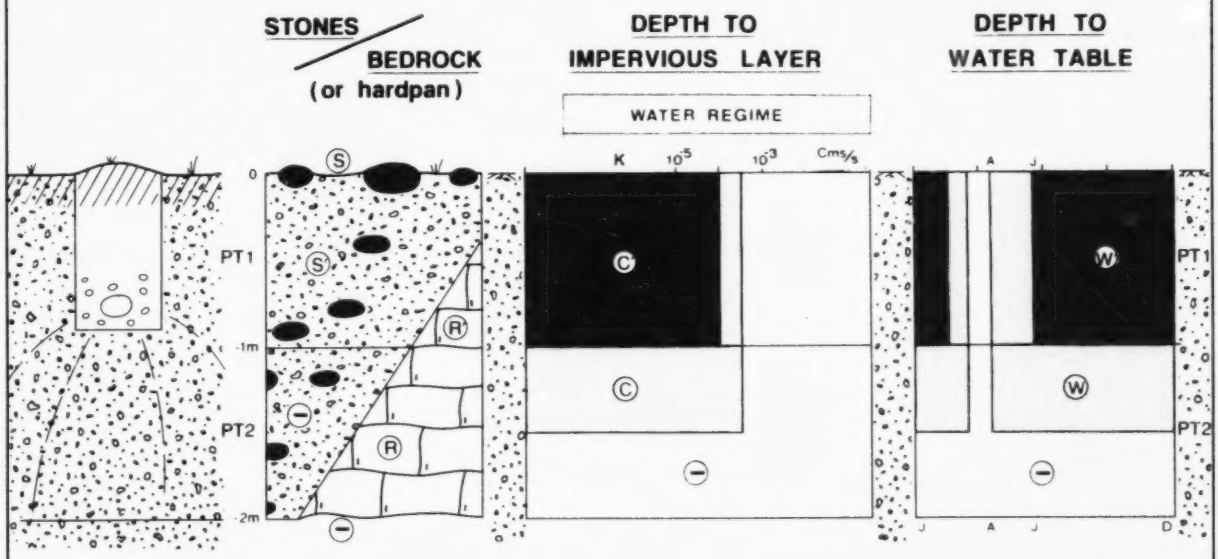


PROBLEM

Extra Filter (z) Required

FACTORS CONSIDERED

Depth to Bedrock (and hardpan) ——— Dr
Presence of Stones ——— Ds
Depth to Impervious Layer ——— Dc
Depth to Water Table ——— Dw



INTERPRETATION

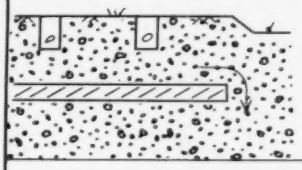
PROBLEM CLASS	STONES in PT1 layer		BEDROCK AND HARDPAN		IMPERVIOUS LAYER		WATER TABLE	
UNLIKELY	below PT1	—	below PT2 ⊖	—	zone ⊖	—	within zone ⊖	—
POSSIBLE	at surface only (S)	Ds	in PT2 only (R)	Dr	zone (C)	Dc	within zone (W)	Dw
LIKELY	in PT1 (S')	Ds'	in PT1 (R')	Dr'	within zone (C')	Dc'	within zone (W')	Dw'

Interpretation (Septic Tanks) (Sheet D)

INTERPRETATION

SEPTIC TANKS

SOIL PROBLEMS DUE TO NUTRIENT ATTENUATION, N



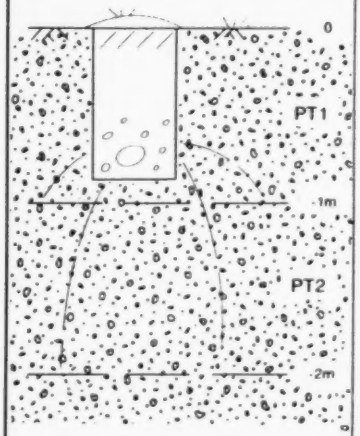
PROBLEM

Improving Soil as a Biological Filter

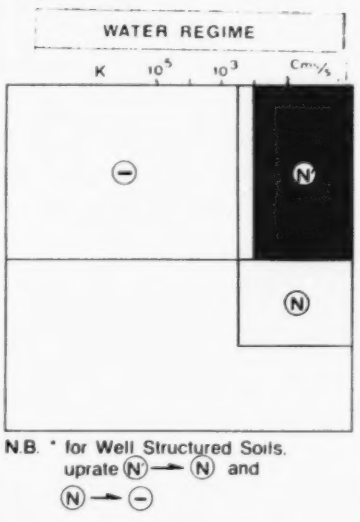
IMPROVEMENTS REQUIRED FOR

Denitrification ——— **Nn**

Phosphorous Retention —— **Np**

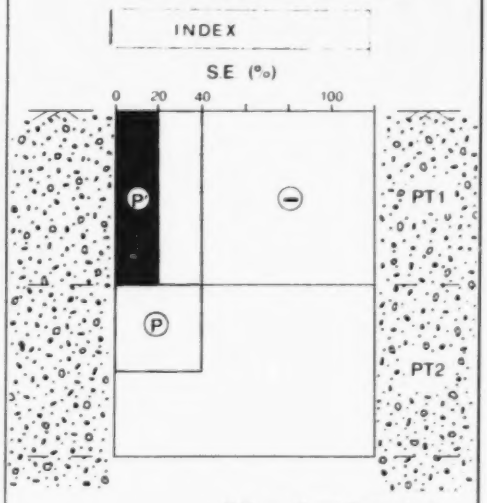


DENITRIFICATION



N.B. * for Well Structured Soils, uprate (N) → (N) and (N) → ⊖

PHOSPHOROUS RETENTION



S.E. = Sand Equivalent

K = Hydraulic Conduct

INTERPRETATION

PROBLEM CLASS	DENITRIFICATION (PT1 and PT2 Layers)		PHOSPHOROUS RETENTION (PT1 and PT2 Layers)	
UNLIKELY	zone ⊖	—	zone ⊖	—
POSSIBLE	zone (N) (*adjust for structure)	Nn	zone (P)	Np
LIKELY	zone (N') (*adjust for structure)	Nn'	zone (P')	Np'

INTERPRETATION

SEPTIC TANKS

SOIL PROBLEMS DUE TO

SETTING AND SLOPE, S

PROBLEM

danger of pollution due to unfavourable settings

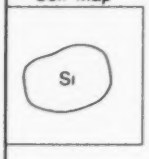
SETTINGS CONSIDERED

Inundation ——— **Si**

Hydrogeology ——— **Sh**

Unfavourable Slopes ——— **Ss**

INUNDATION



Overland Flow

Si { v.p. drained or peaty or organic soils

Floodplain

Si' { predicted floodplain

HYDROGEOLOGY

NB

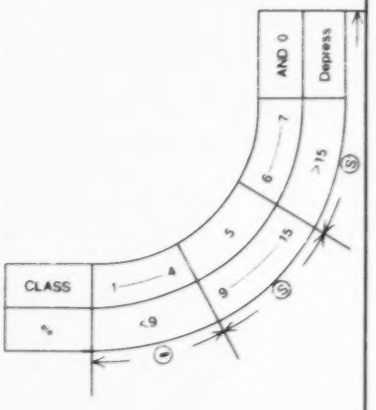
1. This aspect is normally beyond the scope and expertise of pedological survey.

2. Where hydrogeological problems appear evident, these may be indicated- but only to emphasize the need for consultation with hydrogeologists.

g.w. D-major ground water discharge areas.

g.w. R-major ground water recharge areas.

SLOPES



INTERPRETATION

PROBLEM CLASS	INUNDATION		HYDROGEOLOGICAL PROBLEMS		UNFAVOURABLE SLOPES	
UNLIKELY	well drained to poor	—	(unaware of any)	—	zone ⊖	—
POSSIBLE	Si as above	Si	g.w. D	Sh	zone (S)	Ss
LIKELY	Si' as above	Si'	g.w. R	Sh'	zone (S')	Ss'

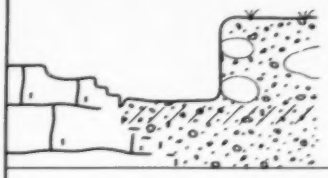
Interpretation (Septic Tanks) (Sheet S)

INTEPRETATION

DWELLINGS

SOIL PROBLEMS DUE TO

EXCAVATION, E



PROBLEM

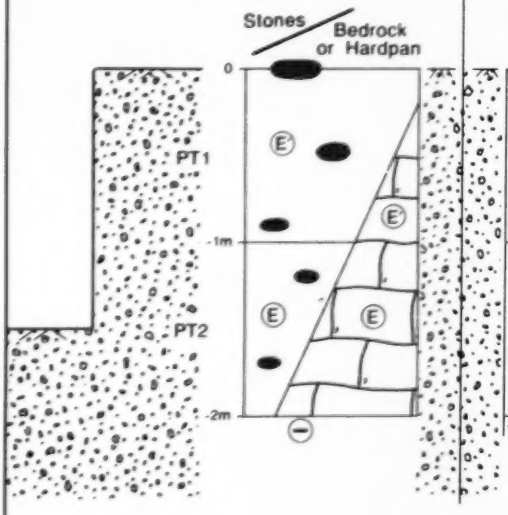
Difficult Excavations

TYPES OF PROBLEM CONSIDERED

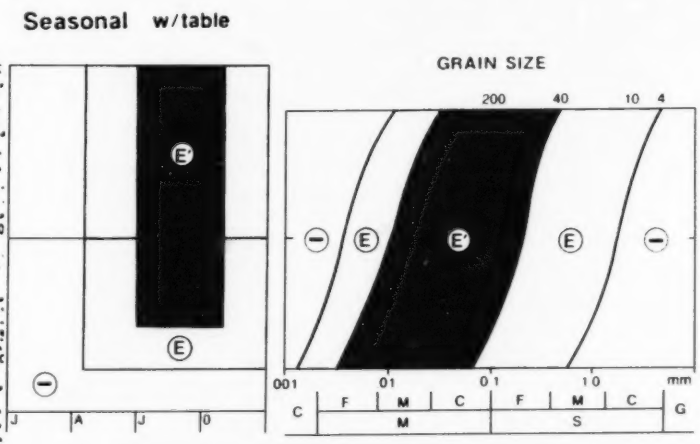
Hard Materials ——— E

Wet Excavation ——— Ew

HARD MATERIALS



WET EXCAVATION



INTERPRETATION

PROBLEM CLASS	HARD MATERIALS		WET EXCAVATION		
			w/table	grain size	
UNLIKELY	Other Soils or Bedrock etc. in zone ⊖	–	zone ⊖ PT1 and 2	All Soils	–
POSSIBLE	Stones s, Hardpan h, Bedrock r } in PT2	E	zone (E)	zones (E) and (E') and organic soil	Ew
LIKELY	Stones s, Hardpan h, Bedrock r } in PT1	E'	zone (E') PT 1 and 2	zone (E') and organic soil	Ew'

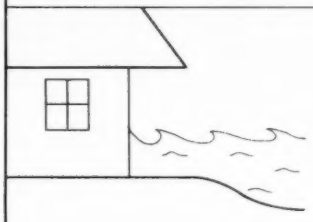
Interpretation (Dwellings) (Sheet E)

INTERPRETATION

DWELLINGS

SOIL PROBLEMS DUE TO

FLOODING, F



PROBLEM

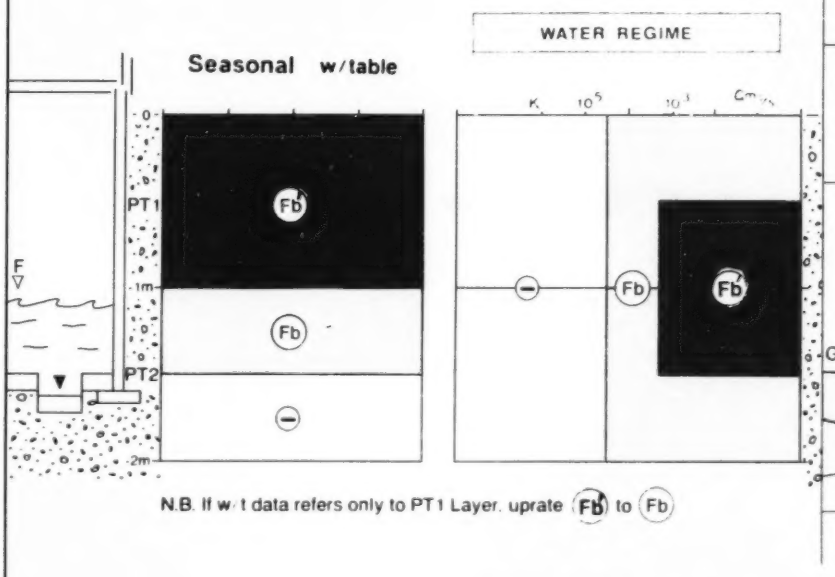
Seasonal Flooding

TYPES OF FLOODING CONSIDERED

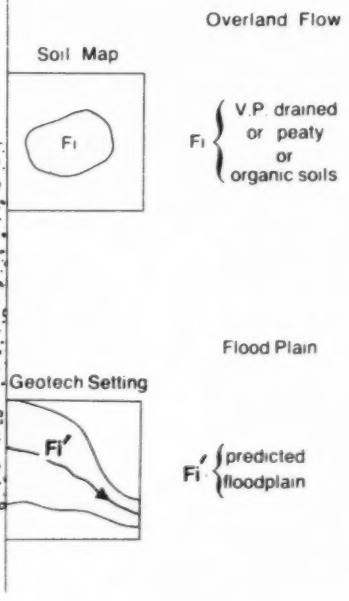
Basement flooding ——— Fb

Inundation of land ——— Fi

BASEMENT FLOODING



INUNDATION



INTERPRETATION

PROBLEM CLASS	BASEMENT FLOODING				INUNDATION	
	w/table	drainage	Hyd. Cond (K)			
UNLIKELY	zone ⊖ PT1 and 2	Well	zone ⊖ PT1 and 2	—	Well drained to poor	—
POSSIBLE	zone Fb	Imperfect to very poor	zones Fb and Fb'	Fb	Fi as above	Fi
LIKELY	zone Fb' PT1 and 2	—	zone Fb' PT1 and 2	Fb'	Fi' as above	Fi'

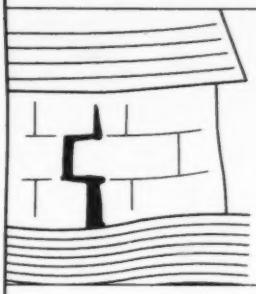
Interpretation (Dwellings) (Sheet F)

INTERPRETATION

DWELLINGS

SOIL PROBLEMS DUE TO

HEAVE OR UPLIFT, H



PROBLEM

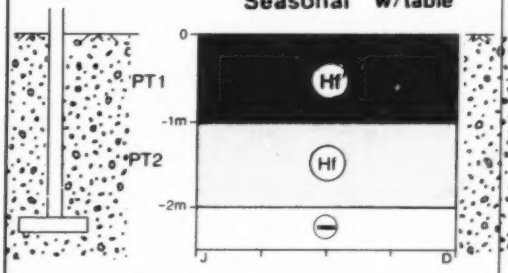
Cracking of walls due to differential heave

TYPES OF HEAVE CONSIDERED

Frost Adhesion ——— Hf
Expansive Clays ——— Hc
Expansive Rocks ——— Hr

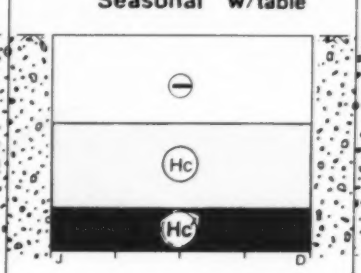
FROST ADHESION

Seasonal w/table



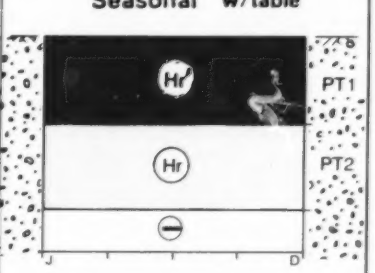
EXPANSIVE SOILS

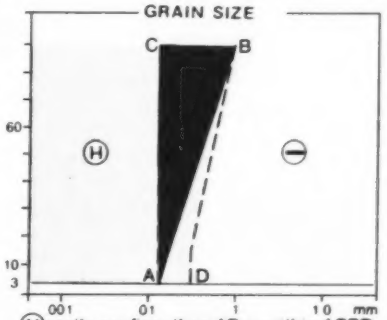
Seasonal w/table



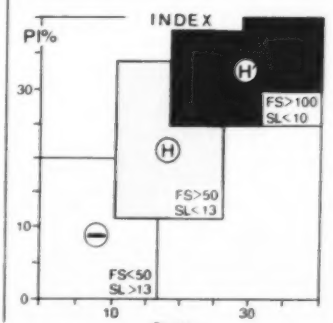
EXPANSIVE ROCK

Seasonal w/table





(H) soils are finer than AB or within ACBD



Hr = Shales with Pyrite

Typical Reactions

$Fe\ S_2 \longrightarrow Fe\ SO_4$ (pyrite) (aerobic bacteria)

$H_2\ SO_4$ and (mica) $\longrightarrow$ K Fe (Jarosite) SO_4 "expansion"

INTERPRETATION

PROBLEM CLASS	FROST ADHESION		EXPANSIVE CLAY		EXPANSIVE ROCK	
UNLIKELY	w/table ⊖ all soils	–	w/table zone ⊖ all soils	–	w/table ⊖ (Hr) and other soils	–
POSSIBLE	w/table zone (Hf) (H) soils in PT1	Hf	w/table in (Hc) (H) and (H') soils in PT1	Hc	w/table in (Hr) (Hr) soils in PT1	Hr
LIKELY	w/talbe in (Hf') (H) soils in PT1	Hf'	w/table in (Hc') (H') soils in PT1	Hc'	w/table in (Hr') (Hr) soils in PT1	Hr'

INTERPRETATION

DWELLINGS

SOIL PROBLEMS DUE TO

SETTLEMENT, S

PROBLEM

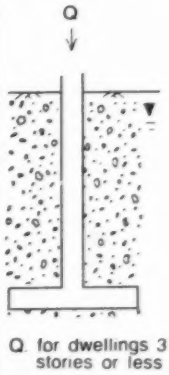
Cracking of walls due to differential settlement

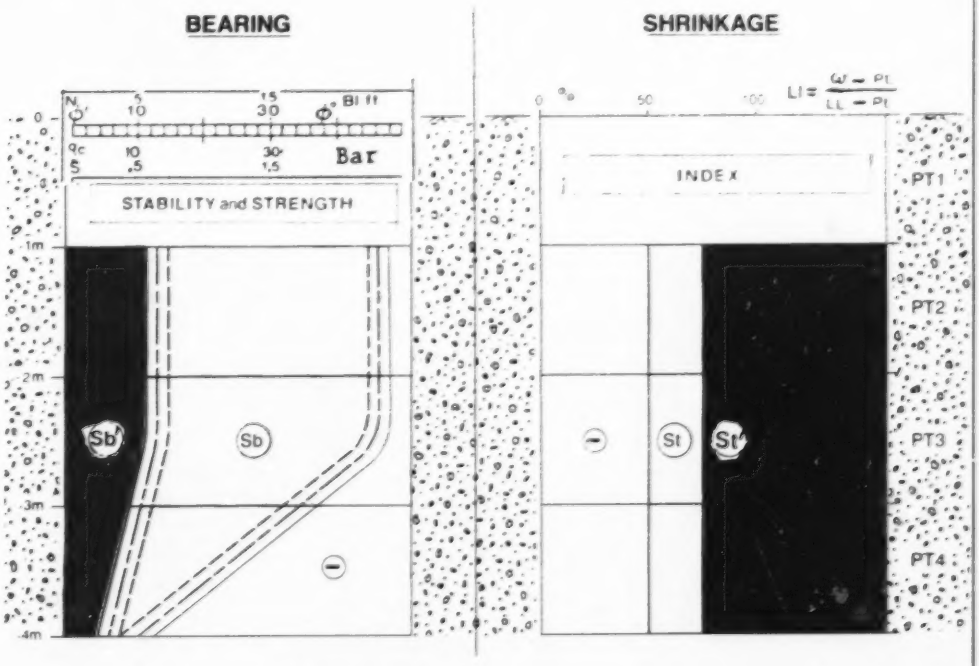
TYPES OF SETTLEMENT CONSIDERED

Bearing (differential) ——— Sb

Subsidence (organic soils) ——— So

Shrinkage (suction and trees) — St





INTERPRETATION

PROBLEM CLASS	BEARING		SUBSIDENCE		SHRINKAGE	
UNLIKELY	PT 2-4 zone ⊖	—	PT 1-4 (O.M. <2%)	—	PT 2-4 zone ⊖	—
POSSIBLE	PT 2-4 zone (Sb) (or other)	Sb	peaty phase PT 2 O.M. >2%	So	PT 2-4 zone (St) (or other)	St
LIKELY	PT 2-4 zone (Sb')	Sb'	PT 1 organic soil	So'	PT 2-4 zone (St')	St'

Interpretation (Dwellings) (Sheet S)